IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/604,011	**Conf. No.:**	1010
Applicant:	Greco et al.	**TC/AU:**	1756
Filed:	06/20/2003	**Examiner**:	Chacko Davis, Daborah
Customer No.:	23550	**Docket**:	FIS920030144US1 (IBMF-0019)

Title: INTEGRATED CIRCUIT FUSE AND METHOD OF OPENING

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Commissioner for Patents
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BRIEF OF APPELLANTS

This is an appeal from the Final Office Action dated December 28, 2005, rejecting claims 1-5 and 7-30. This Brief is accompanied by the requisite fee set forth in 37 C.F.R. 1.17 (c).

REAL PARTY IN INTEREST

International Business Machines Corporation is the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

STATUS OF CLAIMS

As filed, this case included claims 1-30. Claim 6 has been cancelled. Claims 1-5 and 7-30 remain pending, stand rejected, and form the basis of this appeal.

STATUS OF AMENDMENTS

A Final Office Action was issued by the Office, dated December 28, 2005, in response to an Amendment that was filed on September 22, 2005 by Applicants. An After Final Amendment was filed on February 28, 2006 in response to the Final Office Action. Pursuant an Advisory Action, dated March 31, 2006, said After Final Amendment was considered, but not entered for purposes of appeal.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides an integrated circuit, a fuse therefor and fuse opening method. The method implements fuse opening using a wet etchant. As a result, there is no explosion that causes damage to surrounding material. In addition, use of the wet etchant allows positioning of a fuse in any metal layer including any non-last metal layer, thus increasing design possibilities

Claim 1 claims a method (see e.g., FIG. 2) for opening an integrated circuit fuse (see e.g., FIGS. 1, 8, 9), the method comprising the steps of: generating at least one opening (see e.g., FIG. 6, item 50; FIG. 9, item 150) to a fuse element (see e.g., FIGS. 1, 2-6 and 8, item 16; FIG. 9, item 116) that couples a plurality of terminals (see e.g., FIG. 7, item 13; FIG. 9, items 13A, 13B) and is located in a non-last metal layer (see e.g., FIGS. 1 and 2-7, item 20; ¶0020); and wet etching (see e.g., FIG. 2, step S7; ¶0026) the fuse element to open the fuse (see e.g., FIG. 7).

Claim 12 claims an integrated circuit fuse (see e.g., FIGS. 1, 8, 9) comprising: a plurality of terminals (see e.g., FIG. 7, item 13; FIG. 9, items 13A, 13B) coupled by a fuse element (see

e.g., FIG. 8, item 16; FIG. 9, item 116); wherein the fuse element is located in a non-last metal layer (see e.g., FIGS. 1 and 2-7, item 20; ¶0020).

Claim 19 claims an integrated circuit (see e.g., FIGS. 1, 8, 9) comprising: a fuse (see e.g., FIG. 9, item 110) including a plurality of terminals (see e.g., FIG. 7, item 13; FIG. 9, items 13A, 13B) coupled by a fuse element (see e.g., FIG. 8, item 16; FIG. 9, item 116); wherein the fuse element is located in a non-last metal layer (see e.g., FIGS. 1 and 2-7, item 20; ¶0020).

Claim 26 claims an integrated circuit fuse (see e.g., FIGS. 1, 8, 9) comprising: a plurality of terminals (see e.g., FIG. 7, item 13; FIG. 9, items 13A, 13B) coupled by a fuse element (see e.g., FIG. 8, item 16; FIG. 9, item 116); wherein each terminal is fully-landed on an upper surface of a wire (see e.g., FIG. 8, item 14; FIG. 6, item 12; ¶0026; FIG. 9, item 112) of the fuse element.

Claim 30 claims an integrated circuit (see e.g., FIG. 8) comprising: an opened fuse area (see e.g., FIG. 7) including a metal liner (see e.g., FIG. 8, item 17; FIG. 9, item 117) of a fuse element (see e.g., FIG. 8, item 16; FIG. 9 item 116), the fuse element having been removed (see e.g., FIG. 2, step S7; ¶0026) to generate the opened fuse area, the metal liner being intact immediately adjacent to, and in non-contact, with (see e.g., FIG. 7; ¶0027) a plurality of terminals (see e.g., FIG. 5, item 13; FIG. 9, items 13A, 13B).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether claims 1-4 and 7-30 are unpatentable under 35 U.S.C. 102(e) over Daubenspeck et al. (U.S. 6,498,385), hereinafter "Daubenspeck."

2. Whether claim 5 is unpatentable under 35 U.S.C. 103(a) over Daubenspeck, in view of

Huggins (U.S. 5,953,577), hereinafter "Huggins".

ARGUMENT

1. REJECTION OF CLAIMS 1-4 and 7-30 UNDER 35 U.S.C. §102(e) OVER DAUBENSPECK

Appellants respectfully submit that the rejection of claims 1-4 and 7-30 under 35 U.S.C. 102(e) over Daubenspeck is defective.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987); see MPEP §2131, p. 2100-69. Because each and every element of claims 1-4 and 7-30 is not found in Daubenspeck, Appellants respectfully request overrule of the rejection under 35 U.S.C. 102(e).

With regard to independent claims 1, 12, and 19, Daubenspeck fails to disclose, *inter alia*, a fuse element that is located in a non-last metal layer. The fuse 114 of Daubenspeck is clearly never in the non-last metal layer. In FIGS. 1A-1G of Daubenspeck, "last metal minus 1 (LM-1) layer segments 108a, 108b" are shown below fuse 114. Col. 8, line 56. Since fuse element 114 is metal and is above LM-1 layer segments 108a, 108b, fuse 114 must be in the last metal layer; and, therefore, logically cannot be in a non-last metal layer. Daubenspeck only discloses opening of the fuse 114 by laser deletion. The "Overview of Present Invention" in Daubenspeck, at col. 7, lines 16-24 states:

> Laser delete of metal fuses can result in corrosion of wiring conductors near the fuses. A section of last metal (LM) line is formed which is left intact in an unblown fuse and is removed in a blown fuse, in order to provide a high resistance. A blown copper wiring fuse can cause corrosion by interrupting or removing a copper portion of a nearby wiring

conductor. A fuse can be blown by shining an infrared (IR) laser on the metal line.

Col. 10, line 64 states: "[f]ollowing laser deletion of fuse line 114c…." As known to those with skill in the art, and as evidenced by Daubenspeck, the only way a fuse can be removed (e.g., blown) by laser deletion is if it is accessible to the laser - in the last metal layer.

With regard to claim 1, Appellants suspect that the Office is misinterpreting the claim to require that the requirement of location in a non-last metal layer modifies the plurality of terminals, but the claim prohibits that interpretation. More specifically, it states that "a fuse element that couples a plurality of terminals and is located in a non-last metal layer." Since the verb is "is," the phrase "located in a non-last metal layer" clearly modifies the fuse element, and not the plurality of terminals. If it were meant to modify the plurality of terminals, grammatical correctness would require the verb to be "are" located in a non-last metal layer. Independent claims 12 and 19, however, even more clearly state that the "fuse element is located in a non-last metal layer."

With respect to independent claim 26, Daubenspeck fails to disclose, *inter alia*, that each terminal is fully-landed on an upper surface of a wire of the fuse element. The Office alleges that this feature is depicted in figure 1G of Daubenspeck. Final Office Action, page 3, item 2. Yet, as figure 1G clearly shows, the fuse terminals 114a and 114e are in the same layer as fuse line 114c. Therefore, it is technically illogical for the terminals to land *on the upper surface of* a wire of the fuse element, if the terminals are within the same layer *as* the fuse element.

Finally, with respect to independent claim 30, Daubenspeck fails to disclose, *inter alia*, that the opened fuse line includes a metal liner as recited. Daubenspeck discloses a liner that exists below segment 114c. Col. 10, lines 64-66. However, Daubenspeck removes the fuse line

114c and "the liner below segment 114c." Id. That is, Daubenspeck does not disclose, *inter alia*, an opened fuse area with "the metal liner being intact immediately adjacent to, and in non-contact, with a plurality of terminals." In view of the foregoing, Daubenspeck does not disclose either "a metal liner of a fuse element" or "the metal liner being intact[.]" Claim 30. It is only through the disclosed non-laser deletion process that this structure is possible.

With respect to features in the dependent claims not specifically referenced herein, the dependent claims are believed to be allowable based on the above arguments, as well as for their own additional features.

2. REJECTION OF CLAIM 5 UNDER 35 U.S.C. §103(a) OVER DAUBENSPECK IN VIEW OF HUGGINS

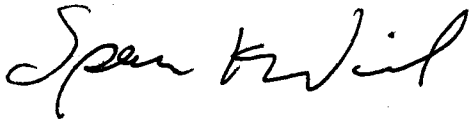
To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify a reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Appellants respectfully submit that the Daubenspeck and Huggins references, taken alone or in combination, at the least, fail to meet the third criterion to establish a *prima facie* case of obviousness. That is as discussed herein, Daubenspeck does not teach or suggest all the claim limitations; and, Huggins does not remedy the deficiencies of Daubenspeck. As such, the rejection under 35 U.S.C. §103(a) is defective.

CONCLUSION

In summary, Appellants submit that claims 1-4 and 7-30 are allowable because the

claimed invention is not anticipated by the cited reference, Daubenspeck. Additionally, with regards to claim 5, the cited references of Daubenspeck and Huggins, taken alone or in combination, fail to meet at least one of the three basic criteria required to establish a *prima facie* case of obviousness.

Respectfully submitted,



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CLAIMS APPENDIX

1. A method for opening an integrated circuit fuse, the method comprising the steps of:

generating at least one opening to a fuse element that couples a plurality of terminals and is located in a non-last metal layer; and

wet etching the fuse element to open the fuse.

2. The method of claim 1, wherein the generating step includes:

applying a photoresist to define an opening area for each opening; and

etching to generate the at least one opening.

3. The method of claim 2, wherein the applying step includes:

depositing the photoresist;

exposing the photoresist using laser light; and

developing the photoresist to define the opening area for each opening.

4. The method of claim 3, wherein the generating step further includes removing the photoresist and a diffusion barrier on the fuse element.

5. The method of claim 1, wherein the generating step includes applying a polymer and ablating the polymer with a laser to define the at least one opening.

7. The method of claim 1, wherein the at least one opening includes one opening to each

side of the plurality of terminals.

8. The method of claim 7, wherein the wet etching step removes the fuse element under the plurality of terminals.

9. The method of claim 1, wherein each terminal is fully-landed on a wire of the fuse element and includes a metal liner surrounding the terminal.

10. The method of claim 1, wherein the fuse element and each terminal include copper.

11. The method of claim 1, wherein the wet etchant includes at least one of sulfuric acid, aqueous ammonium persulfate, hydrogen peroxide and water.

12. An integrated circuit fuse comprising:

a plurality of terminals coupled by a fuse element;

wherein the fuse element is located in a non-last metal layer.

13. The integrated circuit fuse of claim 12, wherein the fuse element includes a wire and each terminal is fully-landed on the wire.

14. The integrated circuit fuse of claim 12, wherein each terminal includes a metal liner.

15. The integrated circuit fuse of claim 14, wherein the metal liner includes one of tantalum, tungsten and titanium nitride.

16. The integrated circuit fuse of claim 12, wherein the fuse element and each terminal include copper.

17. The integrated circuit fuse of claim 12, wherein each terminal includes a horizontal wire and a vertical stud, and the fuse element includes a wire that couples the vertical studs.

18. The integrated circuit fuse of claim 12, wherein a first terminal includes a horizontal wire and a terminal vertical stud, a second terminal includes a horizontal wire, and the fuse element includes a wire coupled to the vertical stud and a fuse vertical stud coupled to the horizontal wire of the second terminal.

19. An integrated circuit comprising:

a fuse including a plurality of terminals coupled by a fuse element;

wherein the fuse element is located in a non-last metal layer.

20. The integrated circuit of claim 19, wherein each terminal is fully-landed on a wire of the fuse element.

21. The integrated circuit of claim 19, wherein each terminal includes a metal liner.

22. The integrated circuit of claim 21, wherein the metal liner includes one of tantalum, tungsten and titanium nitride.

23. The integrated circuit of claim 19, wherein the fuse element and each terminal include copper.

24. The integrated circuit of claim 19, wherein each terminal includes a horizontal wire and a vertical stud, and the fuse element includes a wire that couples the vertical studs.

25. The integrated circuit of claim 19, wherein the fuse element includes a horizontal wire coupled to a terminal vertical stud of a first terminal and a fuse vertical stud coupled to a horizontal wire of a second terminal.

26. An integrated circuit fuse comprising:

a plurality of terminals coupled by a fuse element;

wherein each terminal is fully-landed on an upper surface of a wire of the fuse element.

27. The integrated circuit fuse of claim 26, wherein each terminal includes a metal liner including one of tantalum, tungsten and titanium nitride.

28. The integrated circuit fuse of claim 26, wherein each terminal includes a horizontal wire and a vertical stud, and the fuse element includes a wire that couples the vertical studs.

29. The integrated circuit fuse of claim 26, wherein a first terminal includes a horizontal wire and a terminal vertical stud, a second terminal includes a horizontal wire, and the fuse element includes a wire coupled to the vertical stud and a fuse vertical stud coupled to the horizontal wire of the second terminal.

30. An integrated circuit comprising:

an opened fuse area including a metal liner of a fuse element, the fuse element having been removed to generate the opened fuse area, the metal liner being intact immediately adjacent to, and in non-contact, with a plurality of terminals.

EVIDENCE APPENDIX

No evidence has been submitted.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.